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IMAGE-STABILISED OPTICAL DEVICES

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(19)

(54) IMPROVEMENTS RELATING TO IMAGE-STABILISED OPTICAL DEVICES

(71) We, BRITISH AIRCRAFT CORPORATION LIMITED, a British Company, of 100 Pall Mall, London, S.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to image-stabilised optical devices of the kind in which a magnified image is stabilised against inadvertent movements imparted to the case of the device by hand tremor of the user or by vibration and buffeting of a vehicle or aircraft on which the device is mounted.

One known form of device intended to be hand held incorporates a gimbal mounted gyroscope which imparts a stabilising action via mirror. Another known form incorporates a gimbal mounted mass which, through its inertia, imparts a stabilising action via a set of prisms. In both cases the stabalising actions take place only at high angular frequencies, low angular frequencies being transmitted from the case to the sight line so that intentional steering actions may be applied by merely turning the case as with a conventional telescope or binocular.

According to the present invention, in an image-stabilised optical device an optical assembly consisting of a support member carrying at least an objective and an associated image-viewing member is mounted within a casing by means of a two axis gimbal system so as to allow limited freedom of movement between the optical assembly and the casing on the two axes, said axes being orthogonal relative to the nominal line of sight of the device and being further arranged to pass through the centre of gravity of the optical assembly the centre of gravity being intermediate the objective and the image viewing member.

The image viewing member may be, for example, an eyepiece or a TV camera etc.

According to a preferred feature of the invention an image intensifier is mounted on the support member in the optical path between the objective and the image viewing member.

According to a further preferred feature of the invention the gimbal system includes constraining means arranged to transmit low frequency movements of the casing to the support member to a greater extent than high frequency movements of the casing.

Further features will appear from the following description with reference to the accompanying drawings where Figure 1 shows a cross section through a preferred form of image stabilised telescope according to the invention whilst Figure 2 shows a cross section through an alternative form of focusing device to that employed in the embodimen of figure 1.

Referring now to Figure 1 the telescope comprises an outer case 10 having a window 11 at one end and a window 12 and an eyeshield 13 at the other end. Handgrips 14 and 15 are provided at opposite sides of the case.

The optical assembly comprises a support member 16 on which is mounted an objective lens 17, an image intensifier 18 and an eyepiece 19. The support member 16 is journalled in bearings carried by a gimbal ring 20 for movement about the axis 21, the gimbal ring being in turn journalled in bearings (not shown) carried by the case for movement about an axis perpendicular to both the axis 21 and the nominal line of sight. The two axes pass through the centre of gravity of the optical assembly, and constraining means are provided in the gimbal bearings for centralising the pointing direction of the optical assembly within the case. The constraining means may be of any known kind and are arranged to provide less constraint for relatively high frequency movements of the

case than for relatively low frequency movements.

The image intensifier 18 is supplied via flexible connections (not shown) from batteries 22 mounted within the handgrip 15 and controlled by a switch 23. The flexible connections may form part of the constraining means.

Focusing is achieved by means of two wedge shaped optical transmitting members 24 and 25, the member 24 being mounted on the case 10 and the member 25 being arranged for movement with respect to the case 10 in the direction of arrow A so as to vary the combined thickness of the two members in the direction of the optical path. This movement is effected through a focus control knob and linkage (not shown).

Apertures 27 and 28 are provided in the support member 16 so as to ensure that the focusing device does not interfere with free movement of the optical assembly.

It will be obvious that when the wedges 24 and 25 rotate about the gimbal pivot centre relative to the support member 16 there will be a lateral displacement of the optical avis at the eyepiece due to refraction into the first wedge and out of the second wedge. There will also be introduced a small amount of chromatic, spherical and astigmatic aberrations into the image due to the tilting of the wedge assembly (which is effectively equivalent to a plate having parallel faces) relative to the optical axis. Both the lateral shift and the aberrations will be a function of the optical path length in the wedges and of their refractive index.

In the alternative arrangement shown in Figure 2 these disadvantages are minimised. In its simplest form this alternative arrangement comprises wedges 30 and 31 and a concave element 32 which is also supported from the case 10. The refractive index and dispersion of element 32 is the same as those of the wedges 30 and 31.

The wedge 30 has a spherical first surface 30*a*, its radius of curvature being centred at the gimbal pivot centre. The additional element 32 is positioned between the wedge 31 and the gimbal pivot centre and has a spherical second surface 32*a*, its radius of curvature also being centred at the gimbal pivot centre. The lens 1 is corrected to provide an optimum image when working through the combination of wedges 30 and 31 and element 32 when the optical axis is normal to the adjacent faces of wedge 31 and element 32.

When the wedges 30 and 31 and the element 32 rotate about the gimbal pivot centre relative to the support member 16 the air space between the wedge 31 and the element 32 is inclined to the axis, thus producing chromatic, spherical and astigmatic aberrations in the image which are a function of the optical path length in the air gap and the refractive index of the adjacent elements. However, since the optical path length in this air gap is substantially shorter than the equivalent air path length of the path in the wedges in Figure 1, the aberrations will be proportionately smaller.

In a practical system, for example, where a lens of focal length 120mm is used, focus down to an object distance of 20mm can be provided with a maximum air gap of 2.3mm. The equivalent air path for a practical design to Figure 1 would be approximately 7mm.

If it is desirable to correct the lens for the meniscus form presented by items 30, 31 and 32, then two further elements 33 and 34 may be added. Element 33 has a flat first surface 33*a* normal to the optical axis and a spherical second surface 33*b*, its radius of curvature being centred at the gimbal pivot centre. Element 34 has a spherical first surface 34*a*, its radius of curvature being centred at the gimbal pivot centre, and a flat second surface 34*b* normal to the optical axis. Elements 33 and 34 are carried by the support member 16.

It may be desirable, in some cases, to incorporate image-forming surfaces into elements 33 or 34 by, for example, making the first surface of element 33 or the second surface of element 34, spherical or otherwise curved.

It may also be desirable, in some cases, to make the refractive index and dispersion of elements 33 or 34 different from the values used for wedges 30 and 31 and element 32 in order to correct residual aberrations on the total system.

WHAT WE CLAIM IS:—

1. An image-stabilised optical device wherein an optical assembly consisting of a support member carrying at least an objective and an associated image-viewing member is mounted within a casing by means of a two axis gimbal system so as to allow limited freedom of movement between the optical assembly and the casing on the two axes, said axes being orthogonal relative to the nominal line of sight of the device and being further arranged to pass through the centre of gravity of the optical assembly, the centre of gravity being intermediate the objective and the image viewing member.

2. An image-stabilised optical device according to claim 1 including an image intensifier mounted on the support member in the optical path between the objective and the image viewing member.

3. An image-stabilised optical device according to claim 1 or claim 2 wherein the gimbal system includes constraining means arranged to transmit low frequency movements of the casing to the support mem-

ber to a greater extent than high frequency movements of the casing.

4. An image-stabilised optical device according to any preceding claim including a focusing device in the optical path arranged to vary the effective length of the optical path, said device being carried by the casing and arranged so as not to interfere with the relative movement of the optical assembly and the casing.

5. An image-stabilised optical device according to claim 4 wherein the focusing device comprises a pair of relatively movable wedge shaped optical transmitting elements mounted in the optical path with their wedge faces opposing each other, the elements being arranged so that relative transverse movement of the opposed faces varies the effective length of the optical path.

6. An image-stabilised optical device according to claim 5 wherein the element nearest the objective is fixed relative to the casing, the face of this element nearest the objective being spherical with a radius of curvature centred on the gimbal pivot centre, and including a further optical transmitting element supported from the case between the movable element and the gimbal pivot centre, the face of this further element nearest the movable element being plane and parallel with the face of the movable element and the other face being spherical with the radius of curvature centred on the gimbal pivot centre.

7. An image-stabilised optical device according to claim 6 including a further optical transmitting element adjacent each of said spherical surfaces, each further element having a complimentary spherical surface and each being mounted on said support member.

8. An image-stabilised optical device according to any preceding claim wherein the image viewing member comprises an eyepiece having a sufficiently large exit pupil to allow for relative motion between the casing and the assembly.

9. An image-stabilising optical device substantially as described with reference to Figure 1 of the accompanying drawings.

10. An image stabilised optical device as claimed in claim 1 and modified substantially as described with reference to to Figure 2 of the accompanying drawings.

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1 549 824 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

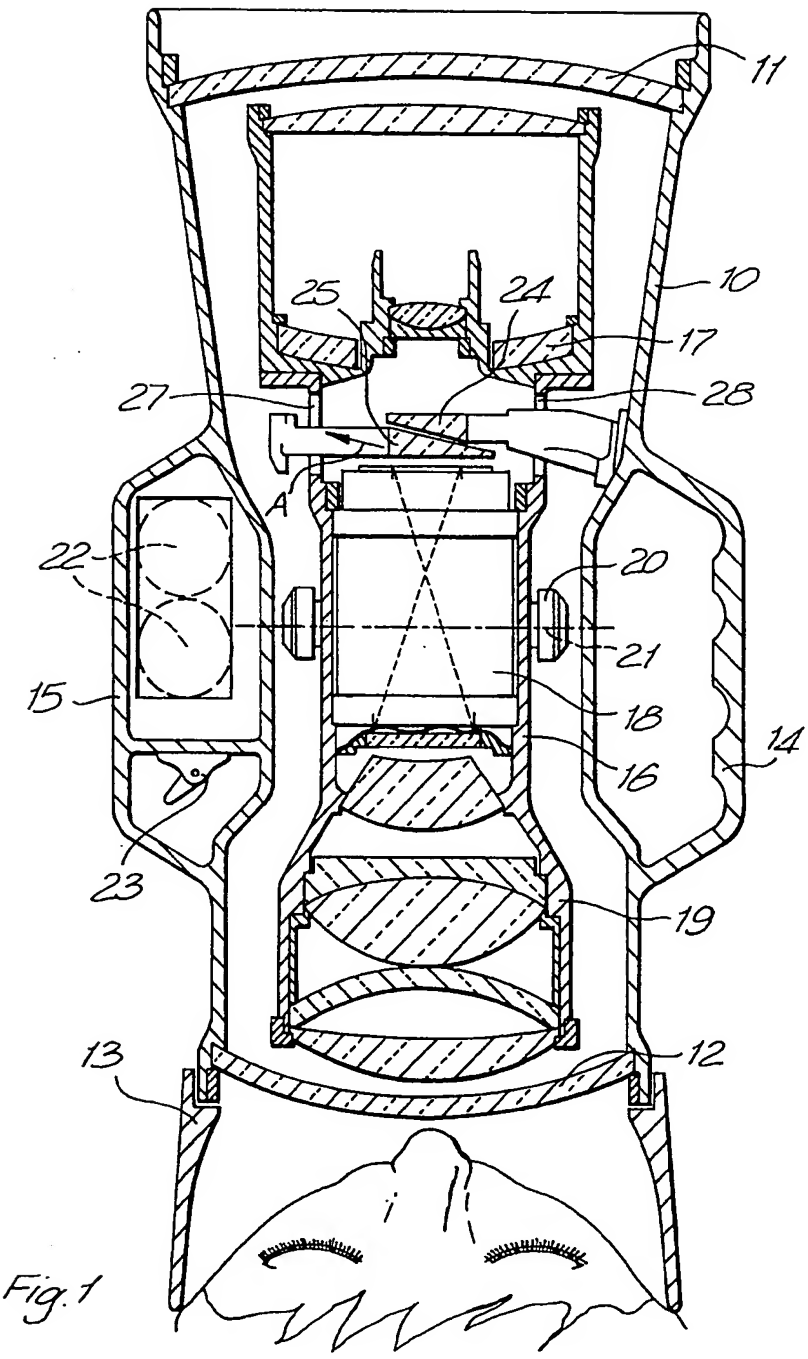

Fig. 1

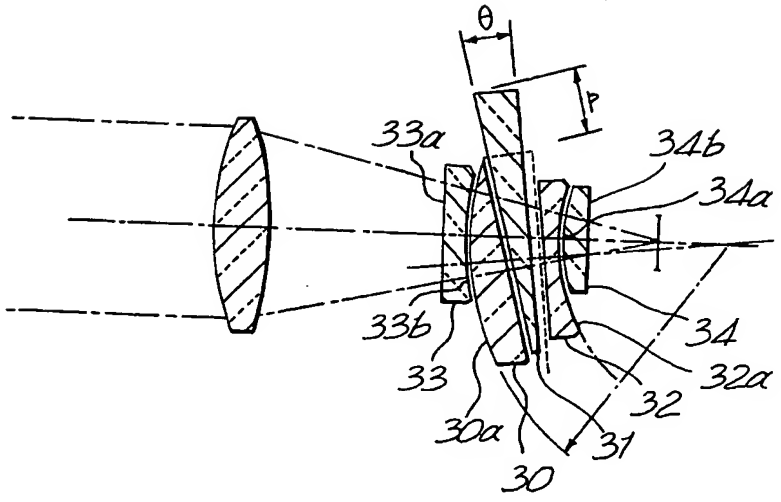

Fig.2